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The GEMINI Project: Integrating new approaches for cross-border geothermal energy projects and stakeholder engagement

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ABSTRACT

The GEMINI project, *Geothermal Energy Momentum on the Island of Ireland*, brings together 15 partners to deliver four new geothermal energy demonstration projects, including the first deep (2km) geothermal energy borehole on the island of Ireland. It will also deliver a range of supporting data, products, toolkits, guidelines and education and training programmes. All aspects of the project will require direct and close engagement with a range of publics and stakeholders.

In 2025, an all-island representative survey of the population was undertaken to assess attitudes to geothermal energy. The collected data informed the design and implementation of engagement processes across several aspects of the project, including formal education and training programmes, general outreach, technical and non-technical dissemination of results, and engagement with policy makers and local and national government officials. The project includes partners with specific expertise in education and training, citizen engagement and deliberative democracy processes for community energy projects.

1 INTRODUCTION

Currently Ireland has an estimated fewer than 18,000 small-scale (mostly domestic) geothermal heat pumps and 10-15 larger scale shallow arrays in the commercial, hospitality, industrial and education sectors – accurate figures are unknown as there is currently no requirement to register such systems. In Northern Ireland fewer than 400 residential and 10 larger scale system are in operation. Increasing the use of geothermal energy for heating/cooling on the island of Ireland will (i) support the EU Renewable Energy Directive (2018/2001), (ii) improve energy security, (iii) reduce emissions and (iv) help to eliminate energy poverty. The heat sector is particularly difficult to decarbonise; in Ireland, heat represents 34% of the energy demand. Fossil fuels account for 90% of heating needs (approximately 83% percent of those fossil fuels are imported (SEAI, 2024). In Northern Ireland heating represents 59% of the energy demand (Department for the Economy, 2024). These heat sources contribute to climate breakdown and are sensitive to market volatility and consumer price increases. This is particularly impactful on those in a state of energy poverty. To increase uptake of geothermal energy on the island of Ireland, the GEMINI project (Geothermal Energy Momentum on the Island of Ireland) will de-risk projects and accelerate the market for geothermal energy through demonstrating real world use in large heat networks. The project has three key objectives:

- de-risk shallow and deep geothermal energy projects,
- develop and support a market, skilled jobs, policy and regulation for geothermal energy and
- create the conditions for meaningful engagement and public participation in developing a clean, sustainable, energy solution on the island of Ireland.

1.1 Project outputs

The technological solutions delivered by the project will be four project demonstration sites: a university (Dublin); a national housing authority a skills and training centre of excellence and mid-depth borehole for a commercial building (Belfast), and a sports centre with swimming pool (Sligo). Two further sites will be used for deep geophysical and geological data collection (Antrim) and community engagement activities (border area of Lough McNeans). In addition, GEMINI will develop and provide multiple open access outputs including: guidance for technical solutions; the CAPEX and OPEX estimates for homeowners and businesses; governance and facilitation of projects; guides and tools for planners and local authorities; procurement guidelines and

business ownership models. These will use experiences and data collected from both the GEMINI sites and others external to the project where relevant. Such outputs are critical to the long-term exploitation of a sustainable energy sector. GEMINI will also create more equal opportunities for communities to contribute towards net-zero targets while supporting sustainable development and improving our environment. The data will prove and estimate subsurface heat resources through geological studies demonstrating the significant potential for geothermal energy across the island. Engagement with communities, businesses, and skills providers will create the conditions needed to sustain a growing market.

These GEMINI solutions will be innovative in their approach; they will deliver replicable workflows for large scale geothermal heating projects supported by scalable/reusable frameworks, guidelines and tools to develop the sector further. The GEMINI consortium can draw on expertise of international and national colleagues who have developed technologies and policy frameworks that will support geothermal energy development in similar non-volcanic geothermal settings.

1.2 Cross-border collaboration

Geothermal energy potential is based on geological conditions which cross-cut political borders. Therefore it is essential to develop the sector collaboratively. GEMINI will ensure a cross-border framework of collaboration and alignment in policy, regulation, research, and business activity. Development of joint education, skills, and training frameworks will ensure that accreditation of businesses, installers, drillers, etc., is recognised both North and South, creating seamless access to markets and the necessary supply of technical expertise.

An important aim of the GEMINI project is to enhance and strengthen the emerging geothermal energy sector while supporting communities in both Ireland and Northern Ireland; together these two legal jurisdictions are referred to as the island of Ireland. A key goal is to ensure the long-term sustainability of the industry and engage as many stakeholders as possible through co-design and participatory engagement activities. This work will also contribute to recommendations and good practice guidelines for future projects. Beyond local communities, stakeholders include the education sector, local authorities, planners and decision makers, policymakers and regulators, researchers, professional bodies and more. Therefore, GEMINI is developing bespoke methods for effective communication and engagement with a wide range of groups.

2 METHOD

2.1 Data collected and baseline public perception

A key project goal is to raise awareness of the opportunities for geothermal energy on the island of Ireland and generate a range of support structures and materials for a wide range of stakeholders, including the general public. To understand the baseline attitudes before the project starts, a representative survey was conducted by a market research company to assess understanding and awareness of geothermal energy on the island of Ireland. A total of 1300 individuals were surveyed; two identical surveys were conducted on the island between 13th and 24th February 2025. This total sample of 1,300 was weighted to match the population breakdown between Ireland (74%) and Northern Ireland (26%). Quotas were placed on the number of interviews achieved in each demographic grouping (age, gender, region and social class) to ensure that it reflected the adult population in Ireland and Northern Ireland.



Figure 1 Map of the island of Ireland indicating the Ireland/Northern Ireland (NI) border, and four provinces.

The total respondents included 49% male and 51% female with 49% from social class ABC1 and 51% from C2DE. In Ireland 29% of respondents were from the Dublin region (the most populous area) with 26% from the rest of Leinster, 27% from Munster and 18% from Connacht and Ulster; in Northern Ireland 18% were from Belfast and 82% from outside Belfast. There was a slightly younger sample in Northern Ireland compared to Ireland. In Ireland respondents comprised 15% Generation Z (18-27 years), 31% Millennials (28-43 years), 26% Generation X (44-59 years) and 28% Baby Boomers (60+ years). In Northern Ireland respondents comprised 22%, 30%, 26% and 22% respectively.

Research suggests that individuals with a stronger, and/or longer, connection to place will have a stronger response to a potential change in the area, for example the development of a community

geothermal installation (Erfani, 2022 and references therein). Therefore, respondents were asked to state their level of connection and attachment to their area. 62% had been living in their current location for ten or more years, 13% (12% in Ireland, 15% in Northern Ireland) between 5-10 years, 13% (14% in Ireland, 11% in Northern Ireland) between 3-5 years, 7% for 1-3 years, and 5% were living in their current location for less than one year. 72% of total respondents considered themselves attached or very attached to their local area with 11% (12% in Ireland, 10% in Northern Ireland) feeling they were not attached to the area. 17% (16% in Ireland, 20% in Northern Ireland) felt neither attached nor not attached. Respondents were also asked if they lived in a rural area or village (26%; 27% in Ireland, 23% in Northern Ireland), small town (22%; 20% in Ireland, 27% in Northern Ireland), suburban (25%; 24% in Ireland, 27% in Northern Ireland) or an urban area (27%; 29% in Ireland, 23% in Northern Ireland).

The majority of respondents had lived in their local area for over 5 years with three-quarters feeling attached to their area. Most lived in a town or city or suburban environment with just over one-quarter in rural areas.
Three in five of respondents had children, half of which were over 18.

2.2 Participatory and Deliberative Democracy

In parallel to the direct data collected from a representative population, two GEMINI partners, the Think Tank for Social Change (TASC) and the Irish Central Border Area Network (ICBAN), have been leading on research to increase community engagement in energy projects, for example through the use of deliberative democracy (Hallewell and Greaney, 2022). Participatory democracy is a governance approach that puts emphasis on engaging citizens through co-creation and deliberative practices to help shape laws and public policies. Deliberative democracy is a process whereby, for example, a community group discusses a potential project, facilitated by an external expert and often with input technical experts (Ercan et al., 2022); it is similar to citizens assemblies (this is one form of deliberative democracy), however the result will be a shared decision for what action show follow and its implementation, rather than a series of recommendations submitted to an external authority or government to implement as policy. This method empowers local community groups to be fully integrated into the decisions making process, for example to progress, or not, with energy projects such as those being considered in the GEMINI project.
The previous study, the Border Transition Project at Lough MacNean area (Hallewell and Greaney, 2022), was conducted by ICBAN and TASC and was based on the principles of participatory and deliberative democracy that involved community engagement over 11 months. The results indicated that local populations are (a) averse to change, (b) local people have concerns regarding shale gas fracking (a previously mooted topic in the area) (c) local populations feel unheard, (d) 26% of the local population are over the age of 60 and (e) local residents are skeptical of new ideas & outside organisations. The outputs and learning from this work will now be applied to the GEMINI project with a new assessment of the potential for a community led geothermal energy project in the Lough MacNeans area where the villages of Belcoo and Blacklion straddle the Irish/Northern Irish border.

3 RESULTS OF THE SURVEY

The data collected from the survey demonstrated that in general the population has a lack of awareness and understanding of geothermal energy, including risks and benefits. Unless specifically stated below, there was no signfiicant difference between responses in Ireland and Northern Ireland.

3.1.1 Views on Heating and Energy Supply

Respondents were asked to rank a list of four factors relating to home energy supply in order of importance. The most important factor in terms of energy supply at home was cost of energy, with 66% of total respondents stating it as the most important; it featured in the top 3 for 94% of people. There was some slight variation between age categories, with Generation X placing more importance on cost of energy (72%) and Baby Boomers placing more importance reliability of supply (27%). Solar and wind were most favourably regarded, with 70% of answers rating them positively and 7% negatively. Regarding geothermal energy for heating, most respondents (53%) had a neutral view, whilst 38% had positive feelings and 9% negative feelings.

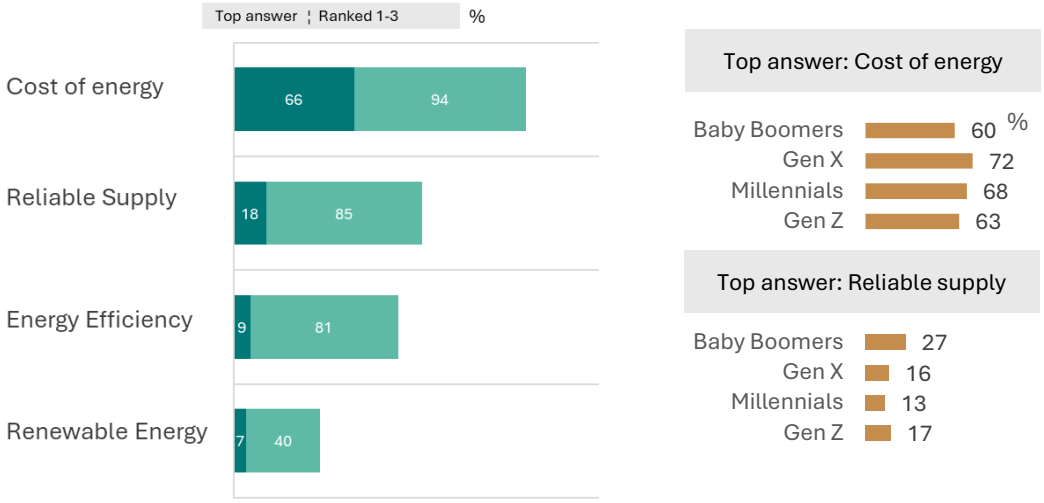


Figure 2 Most important factors in terms of home energy supply. Responses from Ireland and Northern Ireland did not vary significantly. (Note: The survey fieldwork took place three weeks after a record-breaking extratropical cyclone, Storm Eowyn, hit the region, causing damage to power lines throughout Ireland and Northern Ireland. Many network customers were without heat and power for days-weeks. This may have influenced responses by some around reliability of supply)

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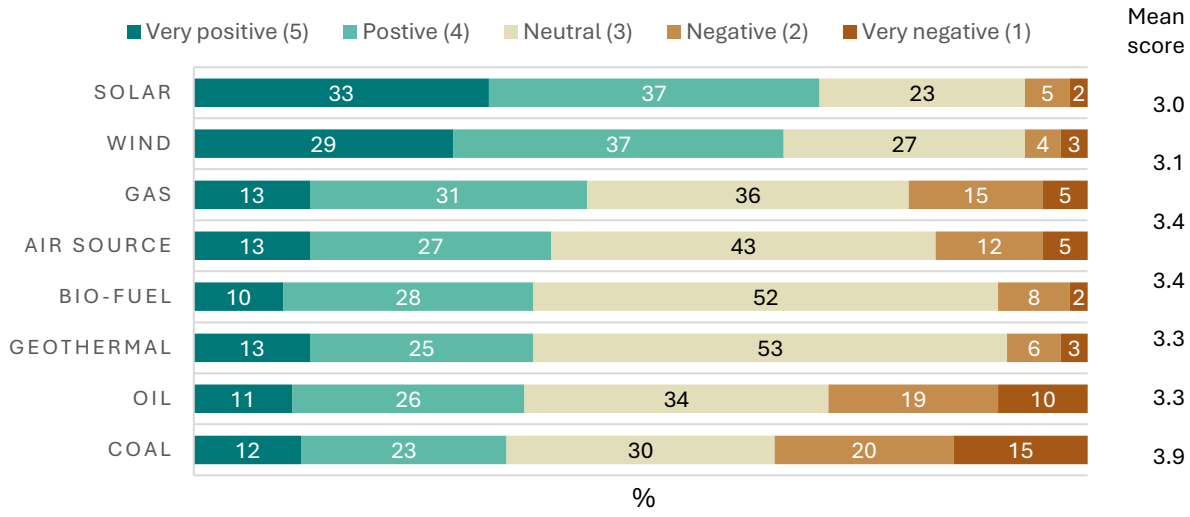


Figure 3 Preferred energy sources. When asked to rate how they felt about each source of energy for their heating, 53% felt neutral about geothermal energy with only 9% feeling negative or very negative.

3.1.2 Knowledge about use of geothermal energy for heating

When asked to select statements (more than one possible) best describing 'geothermal energy', 55% of respondents selected the correct definition – 'Energy obtained from Earth's crust, often used for heating and electricity generation' or 'Energy derived from the sun's rays that heats soils, which can be used for heating buildings'. Of all participants, 28% (27% Ireland, 31% Northern Ireland) selected 'don't know'. For subsequent opinions to be valid, at this point the survey included a short paragraph of factual information on the source of geothermal energy and the methods used to access it.

Participants were asked how much they knew about using geothermal energy for residential heating via ground source heat pumps. Over 90% of respondents stated they knew either nothing (50% Ireland; 57% Northern Ireland) or 'a little' (43% Ireland; 35% Northern Ireland). Responses were similar for knowledge of using geothermal energy for non-residential heating use: nothing (61% Ireland; 65% Northern Ireland); little (31%

Ireland; 29% Northern Ireland). Gen Z and males were roughly twice as likely to have knowledge of these methods of heating as Gen X and females.

The island of Ireland's low take-up of geothermal energy was confirmed in a short statement and then respondents were asked for their views on why this might be. Respondents were asked to rank the most likely reasons (1-5) from a prepared list of 13 statements.

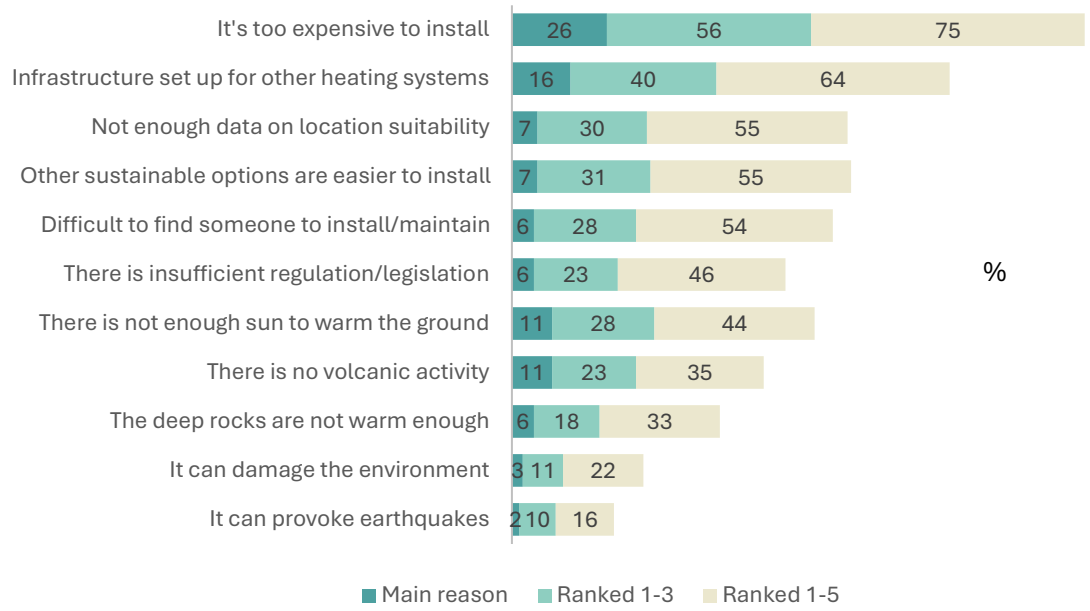


Figure 4 Perceived reasons why geothermal energy is not commonly used on the island of Ireland

The top three most popular reasons were thought to be high cost, difficulties in converting existing systems and not enough data on whether a location is suitable.

3.1.3 Benefits and drawbacks of geothermal energy systems

Participants were asked to read a short piece of illustrated text on how a geothermal energy resource is supplied using shallow and deep systems. This background clearly described drilling activities and showed installations from 200m to depths up to 6km. Respondents were asked how many geothermal boreholes over 500 metres were in use in Ireland today - there are currently none. Only twelve per cent (12%) of all responses selected this option; a third of respondents recorded 'don't know' (other responses include 1-10, 11-50 or >50). There was a significant difference among generational responses, with over 8 in 10 Gen Z and 65% of Millennials believing that deep geothermal boreholes are used for heating on the island of Ireland.

In order to gauge whether there would be support for a deep geothermal well, respondents were asked how supportive they would be towards the development of one in their local community, for example, to heat a swimming pool, library or social club. Of all respondents, 51% were supportive or very supportive; 39% neutral; 10% not, or not at all, supportive. Northern Ireland respondents were slightly less supportive, but felt neutral rather than not supportive. The unsupportive cohort were then asked if they would engage in any activities against development of a new deep (over 500m) geothermal energy system: 54% indicated they would engage in activities such as signing a petition, contacting a local politician or participating in a social media campaign. Their reasons for this included: "As so little is known, I feel damage to our grounds to harvest this heat outweighs any benefits"; "Because enough research is not available on the long-term effects of this form of heating"; "Disagree with the depth of digging/disrupting the land when alternatives in heating can be used at much less invasive techniques", and "Don't feel comfortable with entering into the earth crust and dealing with the unknown, what happens if earthquakes result from the interference, I believe there is more planet friendly options available out there".

Regarding direct and indirect benefits of geothermal energy from heating, respondent were asked to rank the top three from eight options: 60% selected reduced dependency on fossil fuels and 55% selected cheaper energy. These two perceived benefits were supported more by Gen X and Baby Boomers and less by the younger

generations. Gen Z respondents ranked improved air quality and national economy and job support more highly than other respondents.

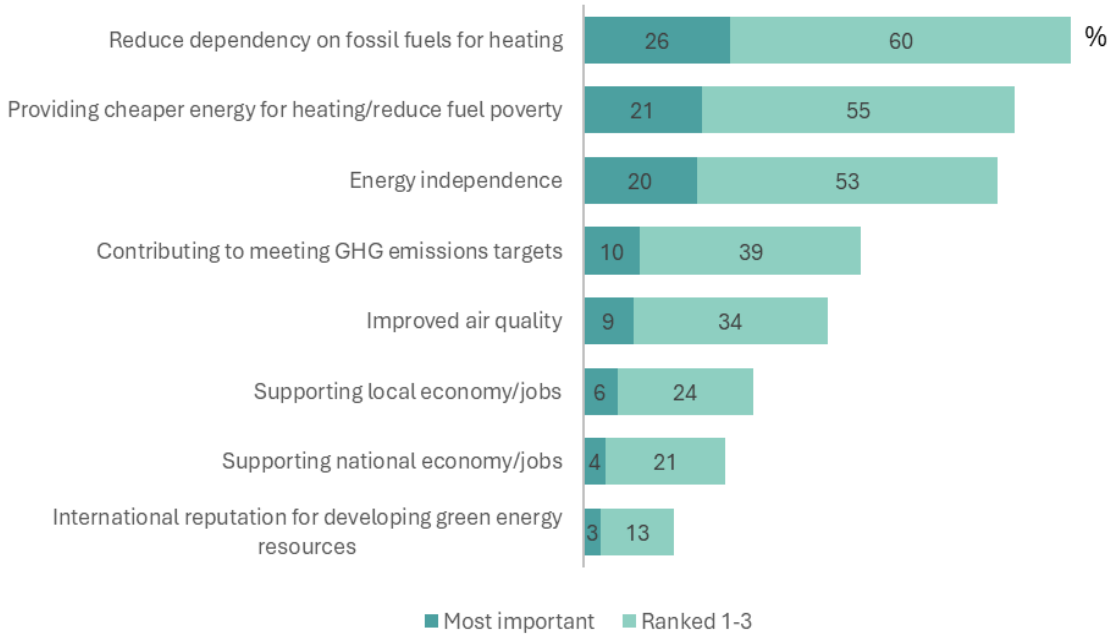


Figure 5 Perceived benefits of geothermal energy.

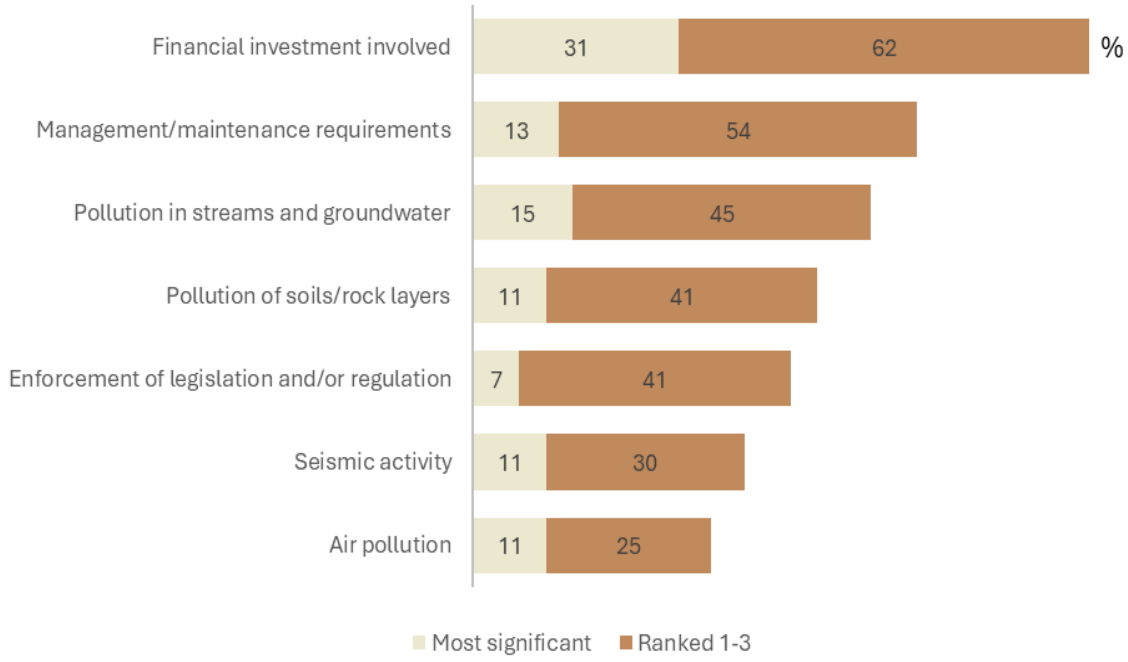


Figure 6 Perceived negative aspects of geothermal energy.

Respondents were also asked to rank their top three risks related to installing geothermal energy heating systems. The financial investment involved was regarded as the most significant risk (62%), followed by management and maintenance (54%), and pollution of streams and groundwater (45%), and of soil and rock layers (41%). Seismic activity and air pollution were each selected as the highest risk by 11% of total respondents. Of all generations, Baby Boomers were most worried about the financial investment, with this being less of a worry for younger generations. Gen Z were most worried about the risk of air pollution and seismic

activity. When asked if they thought these risks would decrease or increase for deep geothermal energy projects, 54% of total respondents believed they increased.

3.1.4 Direct engagement and trust in Geothermal Energy projects

To investigate whether trust in, and support for, geothermal energy might be related to feelings around control of such activities, this section focused on questions relating to the community voice. Respondents were asked to what extent the local community should have a say in estimating whether geothermal energy might be a suitable heating resource in their area. 40% considered local groups should have some say in these aspects; 6% said not at all and 19% only a little. Over 43-year-olds were more likely to agree with greater input.
Regarding how a new geothermal resource might be managed, half of respondents believed the local community should have a say. This changed little between Ireland and Northern Ireland. Older generations were most keen on the community being involved.

Respondents were asked if their community had a meaningful voice in how a new geothermal energy resource is eventually approved and managed, to what extent they would support a new deep (over 500 metre) resource being developed for their local community facility. Broadly half were supportive or very supportive, with differences between Ireland (51%) and Northern Ireland (40%). 11% of respondents from Ireland were not supportive; 14% from Northern Ireland were not supportive. The most substantial segmental difference in expression of support was between male and female respondents, 56% and 41% respectively.

To gauge the potential level of engagement, respondents were asked to select from a list of five activities which public engagement initiatives around geothermal energy they would be willing to participate in. 94% would participate in some form of initiative, with surveys (85%) and education (75%) the most popular. Generational spread was fairly consistent except when responding to an option to be active on digital platforms to provide continuous feedback; where 40% Baby Boomer respondents responded favourably compared to an overall proportion of 60%.

Respondents were asked to state the level of trust in a range of organisations that provide information about science and exploration activities. 50% trusted researchers and academics completely or a lot. 47% trusted the national geological surveys completely or a lot and environmental and environmental advocacy groups 31%. National and local government was trusted (22% and 19%, respectively) with traditional media (radio, television, newspapers) trusted by 18% and social media sources trusted by only 9% of respondents. There were some distinctions between Ireland and Northern Ireland, with little or no trust higher in Northern Ireland respondents compared to Ireland for national government (50% vs 39%), local government (54% vs 41%) and traditional media (58% vs 40%). 12% of Gen Z more likely to trust social media than older generations (3-4%)

In response to the final question 'If available and cost effective, how likely would you be to install/use geothermal energy to heat your home?', approximately half responded positively (Ireland 53%, Northern Ireland 47%), with more males and younger generations being in favour than females and the older generations.

4 DISCUSSION

By collecting population data and public perception information through carefully designing surveys, and by segmenting the stakeholder groups, bespoke communication channels and materials can be designed. For example, different groups (e.g. defined by age) prioritise different aspects of energy for heating their own homes. There was also a distinction between Ireland and Northern Ireland for some elements suggesting that the information required for impactful and local decision making may vary.

In general, there was a substantial lack of knowledge about, and awareness of, geothermal energy on the island of Ireland for residential heating, but particularly for non-residential heating. Females and older generations have lowest awareness. More than 40% of respondents don't understand what geothermal energy is or how it works as a renewable resource. Greater than half didn't know anything about using geothermal energy for heating for residential use; greater than 60% didn't know anything about using geothermal energy for heating non-residential buildings. However, overall this has led to a 'neutral' view of geothermal energy rather than a negative one – people do not yet feel informed enough to make a decision. Previous work has indicated that when it comes to information, first impressions last. That is, people tend to form opinions based on the first information they receive, even if factually proven to be incorrect later; this is know as the primacy effect (Poluektova et al., 2024). In terms of trust in information providers, this is greatest with regard to researchers/academics and geological surveys.

Respondents were also provided an opportunity to provide written feedback on any aspect of the survey. Several stated that they found the topic interesting and wanted to earn more: 94% of respondents also agreed they would participate in public engagement activities surrounding exploration and development of a geothermal resource for their community. There is also a low level of opposition to geothermal energy with only 5% stating they would not support a local geothermal project and would, for example, sign petitions or write to their government representative.

5 CONCLUSION

The data collected has supported the development of a Communications Strategy for the project. This was developed using the results of the survey, experience and expertise from the 15 partners, and the guidance from an external professional communications company. For two of the physical demonstration sites (Dublin and Antrim) local, tailored communications strategies have also been developed as examples of best practice for local engagement. In addition, the GEMINI project provides an exceptional opportunity to combine previous research with deliberate democracy techniques, public facing activities, co-produced education materials, and targeted stakeholder workshops. This allows the GEMINI team to co-design and co-create materials with key stakeholder groups which can be used for a wide range of geothermal energy projects. By understanding and targeting audiences, it ensures the creation and testing of bespoke, relevant information to distribute via specific media and communications channels to deliver wide ranging impact across the island. The aim is to create a population, and a governance model, that can make informed decisions about energy needs and policies.

The initial project products comprise (i) general graphics and infographics specifically designed for the island of Ireland, and (ii) education and teaching materials including short videos to provide context and background information for teachers, and co-designed teaching materials developed through workshops between practitioners and educators on from both jurisdictions. These are accompanied by a series of blogs, audio/podcast style interviews and other digital content is distributed via the website and social media, along with input into national media and documentaries by the GEMINI partners. Workshops for specific target groups (e.g. engineers and architects, policymakers and regulators etc) are also being delivered throughout the duration of the project. The combination of these tools will provide opportunities to increase and improve awareness and information about geothermal energy across the island of Ireland.

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